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EFFECT OF THE POCATERRA POWER DEVELOPMENT ON LOWER KANANASKIS LAKE.

by R. B. Miller.

The Calgary Power Company is presently building a dam across the Kananaskis River about 1¾ river miles below the Lower Kananaskis lake and approximately ¾ miles below the point where Smith-Dorrien Creek enters the river. The effect of this dam will be to raise the level of the Lower Kananaskis lake from 5432 feet to 5469 feet, a rise of 37 feet. The dam will also permit the lowering of the lake to 5426 feet, some six feet below its present level. The total maximum annual fluctuation in level will be, therefore, 43 feet.

During the period June 9 - 15, 1954, Mr. R. C. Thomas and myself investigated the lake with the purpose of estimating what effect the dam would have on the rainbow trout fishery. A further visit was made with M. J. Paetz added to the party from June 30 to July 6. It was our intention to spend a longer period and study the river below the dam; however, construction work at the damsite had so dirtied the river that no observations could be made.

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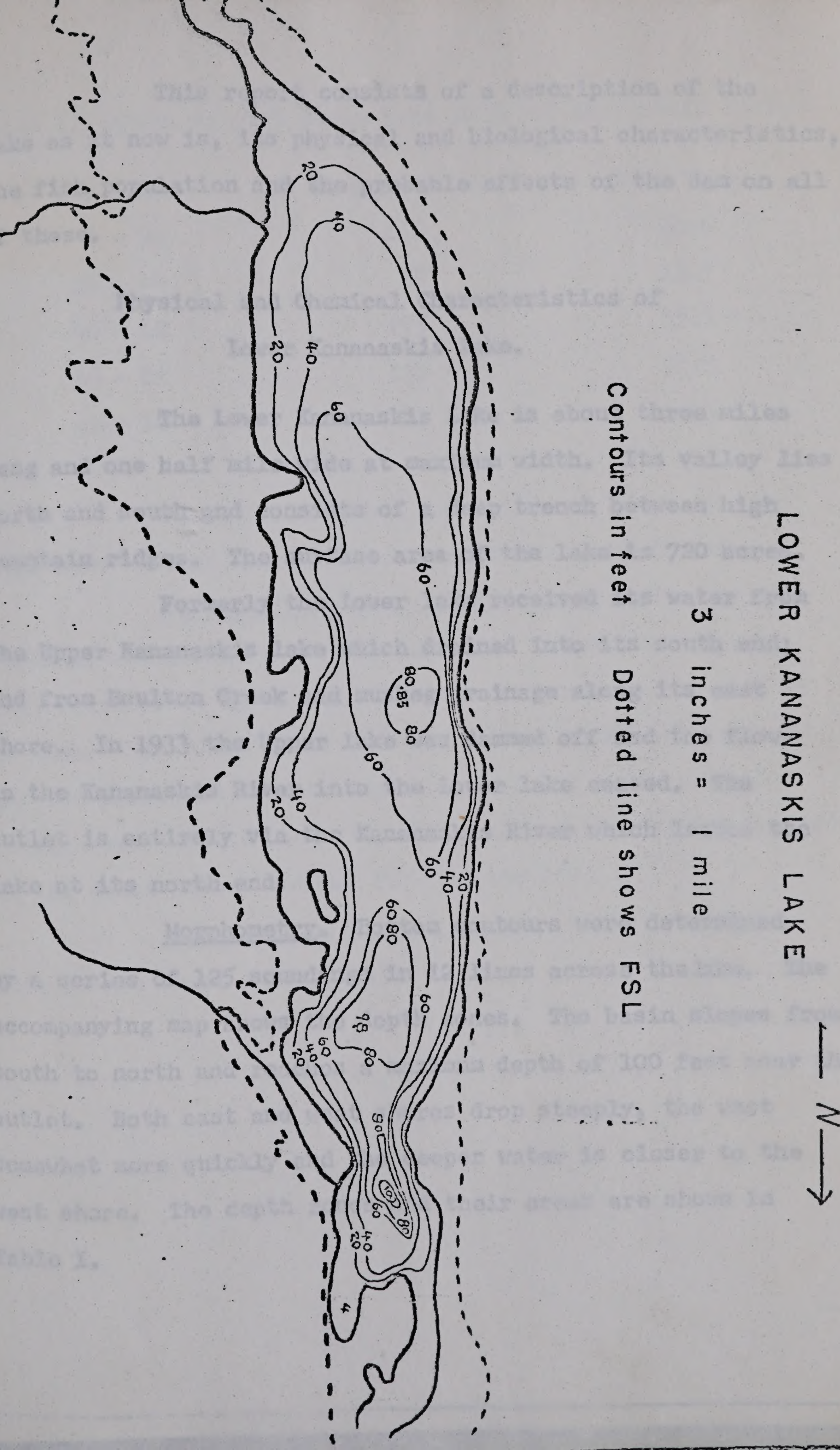


LOWER KANANASKIS LAKE

3 inches = 1 mile

Contours in feet Dotted line shows FSL

This report consists of a description of the lake as it now is, its physical and biological characteristics, the fish population and the probable effects of the dam on all of these.

Physical and Chemical Characteristics of Lower Kananaskis Lake.

The Lower Kananaskis Lake is about three miles long and one half mile wide at maximum width. Its valley lies north and south and consists of a deep trench between high mountain ridges. The surface area of the lake is 720 acres.

Formerly the Lower lake received its water from the Upper Kananaskis lake which drained into its south end; and from Boulton Creek and muskeg drainage along its east shore. In 1933 the Upper lake was dammed off and the flow in the Kananaskis River into the Lower lake ceased. The outlet is entirely via the Kananaskis River which leaves the lake at its north end.

Morphometry. Bottom contours were determined by a series of 125 soundings in 12 lines across the lake. The accompanying map shows the depth zones. The basin slopes from south to north and reaches a maximum depth of 100 feet near the outlet. Both east and west shores drop steeply, the west somewhat more quickly and the deeper water is closer to the west shore. The depth zones and their areas are shown in Table I.

Table I. Areas of each depth zone in Lower Kananaskis Lake.

Depth Zone	Area in Acres	% of Total
0 - 20	166	23.0
20 - 40	99	13.7
40 - 60	255	35.4
60 - 80	155	21.4
over 80	47	6.5

Table I shows that two-thirds of the lake is more than 40 feet deep. The average depth is 44.7 feet.

Effect of the dam on morphometry. The dam will flood an additional 900 acres at FSL. The maximum depth will increase to 137 feet. The average depth at FSL will be 47 feet. The large areas of shallowwater at FSL compensate for the increased maximum depth so that the average depth changes very little and will, in fact, remain roughly constant at all water levels between FSL and low level.

Temperature, oxygen and pH. Series taken on June 15 are shown in Table II.

Table II. Temperature, dissolved oxygen and pH at different depths in Lower Kananaskis Lake.

Temp. °C.	Oxygen (cc./l.)	pH	Depth (feet)
7.6	8.6	7.4	0
7.5	-	-	5
7.2	-	-	10
7.1	-	-	15
6.7	-	-	20
6.1	-	-	30
4.8	8.6	-	50
3.9	7.6	-	73
-	4.4	7.1	95

Most of the lake is saturated with oxygen; the temperature diminishes gradually to a minimum of 3.9°C. at 73 feet. It is unlikely that stagnation would ever occur.

The transparency on June 15 was 20.5 feet.

Plankton

Hauls with a #20 silk net were made at 3 stations on June 15; a surface tow was made the same day. Surface tows and a haul were also made on July 2. The volume of plankton was very small; it consisted almost entirely of crustaceans (mainly Diaptomus) with a very sparse plant plankton. Findings were the same as those of Rawson in 1947.

Bottom Fauna

A series of 12 dredgings was taken with a six-inch Ekman dredge. The results of these are shown in Table III.

Table III. Dredgings in Lower Kananaskis Lake, June 14, 1954.

No.	Depth (feet)	Volume (cc./sq.ft.)	Number of animals per dredging Midges	shrimps	worms	clams	snails	mis
1	5½	1.6	38	2	7	0	0	5
2	12	2.8	60	3	3	6	1	-
3	18	1.6	44	0	0	2	0	0
4	25	3.6	103	2	0	11	1	0
5	30	3.6	96	0	0	47	0	0
6	41	3.2	61	2	0	0	0	0
7	47	1.2	42	6	0	41	0	0
8	62	0.8	52	0	1	13	0	0
9	69	1.6	54	6	0	2	0	1
10	88	0.4	16	0	0	9	0	0
11	82	0.2	9	0	0	18	0	0
12	96	0.2	6	0	0	7	0	0

The principle bottom animals are midge larvae, small clams (Sphaeriidae) and fresh water shrimps (Amphipoda Gammarus), in that order. The miscellaneous column includes nematodes, caddis larvae, water mites and mayfly nymphs. It is important to note the depth distribution: most of the bottom

fauna grows in the first forty feet! Our findings as set forth in Table III are similar to those of Rawson in 1936 and 1947.

Dredgings were supplemented with hand collections along the shores. These revealed a fairly rich fauna of jawed leeches (*Erpobdella punctata*), caddis larvae, stonefly nymphs, mayfly nymphs and snails (*Physa*).

When the dam is built and the lake level is caused to fluctuate more than 30 feet each year most of the bottom fauna will be deleteriously affected. The small clams, mayfly and stonefly nymphs, leeches, snails and probably shrimps will be seriously reduced in numbers. These animals are either slow moving or require a full year of constant water level to develop. The only bottom creatures which will remain in significant numbers will be midge larvae.

The Fish Population of Lower Kananaskis Lake

The following fishes were found:-

Rainbow trout (*Salmo gardneri*) ?
Rainbow x cutthroat hybrid (*S. gardneri* x *S. clarki*)
Dolly Varden (*Salvelinus alpinus*)
Common sucker (*Catostomus commersoni*)
Northern sucker (*Catostomus catostomus*)
Brook stickleback (*Eucalia inconstans*)

This rather meagre variety is typical of mountain lakes of the eastern slopes.

The population was sampled by eleven gill net settings and by seine hauls. The record of the net settings and catches is shown in Table IV.

Table IV. Gill net settings and catches in the Lower Kananaskis Lake.

No.	Mesh size	Depth (feet)	R. B.	Hybrids	D. Varden	Suc
1	50^{x} - 3"	12 - 28	0	0	0	
	50^{x} - $3\frac{1}{2}$"					
2	50^{x} - 3"	25	0	3	3	
	50^{x} - $3\frac{1}{2}$"					
3	100^{x} - 4"	$3\frac{1}{2}$ - 27	2	0	0	
	50^{x} - $2\frac{3}{4}$"		0	0	1	
4	100^{x} - $5\frac{1}{2}$"	10	0	16	0	
5	100^{x} - 4"	4 - 12	0	0	0	
	50^{x} - $2\frac{3}{4}$"		0	0	0	
6	100^{x} - 3-$3\frac{1}{2}$"	4 - 8		7	13	
7	100^{x} - 4"	5 - 20	0	1	1	
	50^{x} - $2\frac{3}{4}$"		0	2	1	
8	100^{x} - $2\frac{3}{4}$"	5 - 8	0	0	4	
9	50^{x} - $1\frac{1}{2}$"	10 - 12	0	0	0	
10	50^{x} - $1\frac{1}{2}$"	15 - 20	0	1	0	
11	50^{x} - $3\frac{1}{2}$"	10	0	1	0	
	Totals		2	31	23	

x 1 northern, 166 common suckers.

The eleven settings were distributed as follows: 2 and 4 across the mouth of Boulton Creek, 1, 6, 8, 9 and 11 in the bay at the south end of the lake, 3 and 5 at the island, and 7 and 10 at the outlet.

There is some uncertainty regarding the history of the trout in the two Kananaskis lakes. It has been inferred that there were no trout in the Upper lake until 1935, when rainbow were planted. At this time the Lower lake contained native cutthroat trout. The rainbow were observed (Rawson, 1938) to have escaped into the Lower lake the year after planting. Later, in 1944, rainbow were planted in the Lower lake and in 1947 Rawson reported that they were well established.

Rawson's records from the lower lake are as follows:-

1936: 1 gill net setting: one cutthroat trout

1947: 4 gill net settings: 52 rainbow and 1 cutthroat. Rawson also reports that many cutthroat were taken by anglers in the Lower lake in 1936.

During our survey we caught 33 trout from the lower lake and 13 from the upper. We also examined another dozen trout caught by anglers from the lower lake. Of all these trout only 3 from the lower lake could be definitely classified as rainbow. The remaining lower lake trout and all those from the upper lake were rainbow x cutthroat hybrids. Some of these showed stronger cutthroat characters than others but none could be definitely described as a pure cutthroat.

We conclude two things from these observations:

(1) The upper lake originally contained cutthroat trout (as several old-timers informed us).

(2) The trout population of both lakes is neither rainbow nor cutthroat, but a hybrid between the two, similar to the fish in the lower Bow River.

Suckers. Another curious change is evident in the records of sucker catches. In 1936 Rawson captured 202 Northern suckers. He records data of Mr. Martin who caught 55, 35, 30, 15, 12 and 8 northern suckers during the years 1942 to 1947, respectively, (while taking trout for eggs). In 1947 Rawson caught 3 northern suckers in four gill net settings. In our survey we captured 166 common suckers and 1 northern sucker! Dr. Rawson (1947) makes no mention of common suckers, but does point to the remarkable decrease of northern suckers. He says the reasons for their decrease are unknown but speculates "presumably the increase in numbers of rainbow and Dolly Varden have been at least partly responsible ..." However, Dr. Rawson also states that if this presumption is true, it is contrary to all his previous experience.

It seems to us that a very probable explanation exists. Northern suckers spawn in fast water and run upstream to do so. With the damming of the Upper lake their spawning ground was eliminated and they have gradually disappeared. Common suckers, which do not require fast water for spawning, have taken over their niche. We observed large schools of spawning common suckers in shallow bays at the south end, along the east shore and in the outlet.

Dolly Varden. We caught Dolly Varden in the ratio of 2:3 trout. Rawson's ratios were 3:1 in 1936 and 5:4 in 1947. It is unlikely that these records indicate any change and it may be assumed that these fish are remaining relatively stable in numbers.

Sticklebacks. These little fish are moderately abundant along the shore and in shallow bays. They were taken only in seine hauls. They probably serve as forage for trout and Dolly Varden in the early part of each summer.

The Hybrid Trout; Growth, Food and Spawning.

Growth. The average length and weight of each age group of hybrid trout are shown in Table V. Also included in the table are 13 trout from the Upper lake.

Table V. The average length and weight of each age group of hybrid trout from Lower and Upper Kananaskis lakes. Numbers of fish of each age group are shown in paranthes

	Lower Kananaskis		Upper Kananaskis	
Age	Length (in.)	Weight (oz.)	Length	Weight
1	5.9	1 (1)	-	-
2	10.5	13 (2)	-	-
3	14.8	24 (2)	13.1	20 (5)
4	18.2	49 (6)	18.1	41 (3)
5	22.0	84 (13)	19.7	53 (1)
6	24.6	107 (5)	22.2	71 (4)

There are several points of considerable interest revealed in Table V. First is the surprisingly rapid growth of the trout. The lower lake fish reach over five pounds in five years. This is very good growth for a mountain lake. As the food supply is only moderately good, this rapid growth suggests a rather sparse population.

A comparison of growth in the two lakes is instructi
It will be observed that at age 3 the fish of the two lakes are very nearly the same length and weight. As they grow older the Upper lake trout fall behind. If one plots a curve of length against weight for trout of both lakes it may be seen that at a length of 15 inches the Upper lake trout weigh about 3 ounces less than the Lower lake trout; at 20 inches they weigh half a pound less and at 25 inches almost one and a half pounds less. This slowing down in growth and loss of condition (i.e., fatness) is undoubtedly the result of deficient food. This is due to the fluctuating water level of the Upper lake. The fluctuations do not interfere with plankton production so that growth in the early years, when plankton is the main diet, remains good. The fluctuations do reduce the production of bottom food - the diet of older trout; consequently after the third year the growth falls off. We confidently predict a similar result from the damming of the Lower lake.

Yet another item of significance in Table V is the age composition of the sample. Twenty-two of the 33 Lower lake trout are five or older. This is in spite of many sets of small nets in an effort to get small trout. Anglers seldom

catch small trout; fishing is usually poor but when a catch is made it is of large trout. These observations suggest that the population is sparse (also indicated by fast growth) and that spawning is not very effective. (The Upper lake sample is not large enough to permit speculation, but the experience of anglers indicates that the same situation probably exists.)

There are no data on growth rates in previous years except that Dr. Rawson states in his report of the 1938 work that the rainbow trout in the Upper lake planted (as fry) in 1935 reached 2 to 2¾ pounds by July, 1938. This is a much better growth than they accomplish at the present time. Perhaps the full effect of the fluctuations in water level had not yet become operative.

Food. Most of the trout examined were ripe or spent fish and feeding was not general. Only 19 stomachs of Lower lake trout had food in them. All of these contained fresh water shrimps. In addition one had eaten leeches; one, midge larvae and one, plankton.

Nine stomachs of Upper lake trout contained food; one had shrimps, 1 trout eggs, 1 caddis larvae, 1 plankton, 1 nematodes and 4 midge larvae. This food selection reflects the impoverishment of the bottom fauna by fluctuating water levels. Rawson noted the predominance of midge larvae (relatively little affected by water level) and the absence of shrimps (considerably affected) in the Upper lake in 1938. The better growth of the lower lake fish and their choice of shrimps suggest that the near absence of shrimps in the Upper lake is largely responsible for the poorer growth.

We may anticipate a similar scarcity of shrimps in the Lower lake and a resulting deterioration of growth of the trout.

Spawning of Lower lake trout. Maturity is reached by most trout in the sixth spring. Three-year-olds were immature, and five out of six four-year-olds were immature and only one out of 13 five-year-olds was immature. The Upper lake trout mature a year earlier; the reason is not clear but it is possibly due to the slower growth,

Our own observations and those of others indicate that running water is required for spawning. Originally there were three spawning runs: one into the river between the two lakes, one into the outlet and one up Boulton Creek. Of these the most important was the first, i.e., upstream into the river between the lakes. The damming of the Upper lake destroyed this run. Next in importance was the outlet run and of least importance was the Boulton Creek run. The run into the river between the lakes was most important for two reasons: first, it is instinctive for trout to move upstream to spawn, and, second, the fry produced would naturally work down into the lake. The fry which hatch in the outlet are extremely vulnerable to being swept downstream instead of working upstream to the lake. The Boulton Creek run is least important because the creek is subject to flooding at spawning time; the other two spawning sites were both free of flooding as both were outflows from lakes.

This year five or six trout struggled up the trickle between the lakes and deposited eggs in a tiny flow about one foot wide and 2 or 3 inches deep. Their contribution to the stock of the lake would be negligible. During the first two weeks of June approximately 70 pairs of trout were counted spawning in the outlet in a $\frac{3}{4}$ mile stretch of rapids below the lake. On July 2 the redds were dug up; a few empty shells and freshly hatched fry indicated that hatching had begun. Most of the eggs were nearly ready to hatch. The approximate date of the hatch is thus established as the first week of July. This means that the trout must go on the redds in May, before the break-up of ice cover on the lake.

On Ju~~ly~~ne 11 the lower 3/4 miles of Boulton Creek contained numerous pairs of trout digging redds. On June 12 the creek rose and the trout disappeared. Careful searches on July 1 and 3 failed to uncover any eggs and it is believed that little spawning took place. This is probably a frequent occurrenc as the maximum run-off and spawning season appear to coincide.

The elimination of the run into the river between the lakes in 1933 has probably led to the present unbalanced age composition in the Lower lake. That is, at the present time, spawning facilities are inadequate to maintain a normal population This conclusion is strengthened by the disappearance of northern suckers (mentioned previously) which have spawning requirements very similar to the trout.

The damming of the river below the Lower lake will eliminate the only dependable remaining spawning area. Boulton

Creek will still be available but it is too subject to untimely flooding to provide a reliable spawning area. It would appear that the trout population in the Lower Lake will largely disappear unless extensive annual stocking is carried out.

The Dolly Varden Population

Twenty-three Dolly Varden were examined. They ranged in size from 13.3 inches and 13 ounces to 28.3" and 10 pounds. Large fish predominated: 13 were over six pounds, 1 over five pounds and 9 were under two pounds.

Growth. The scales of charrs are generally unreliable for age determination. The ages of the L. Kananaskis Dolly Varden as given in Table VI must be regarded mainly as guesses.

Table VI. The average length and weight of each age of Dolly Varden in Lower Kananaskis Lake.

Age	Average Length (inches)	Average Weight (ounces)	No. of fish
3	14.2	17	7
4	15.6	21	2
5	-	-	0
6	24.7	99	5
7	26.5	125	8
8	28.3	158	1

Table VI shows that the Dolly Varden grow fairly rapidly but lag considerably behind the trout. The small number of 4- and 5-year-old fish suggest that reproduction is not occurring to full extent every year. Possibly the Dolly Varden, like the trout, suffer from insufficient spawning area.

Maturity. The three-year-olds were all immature. One four-year-old appeared to be going to spawn this coming fall. All the older fish were mature. Maturity probably is reached in the fifth summer by some and in the sixth by most.

Food. 18 stomachs contained food. The food items and the number of stomachs in which each was found are shown in Table VII.

Table VII. Food of Dolly Varden in Lower Kananaskis lake, June, 1954.

Item	Number of stomachs
Leeches	10
Shrimps	7
Trout	4
Trout eggs	1
Suckers	5
Fish remains (unidentified)	1

Of 18 stomachs, 10 contained leeches; one 19½ ounce fish had eaten 30 leeches! Leeches were found equally in large and small Dolly Varden. The shrimps were also found in fish of all sizes. Ten char had eaten fish; these ten were all large, over five pounds and six years. The trout eggs

were found in a fish of one pound weight.

The apparent dependence of the younger Dolly Varden on bottom foods (leeches and shrimps) suggests that they will be seriously affected by a food shortage when the dam is completed.

In general the conclusions on food and spawning drawn for the hybrid trout apply also to the less desirable but, nevertheless, very valuable Dolly Varden.

Common Suckers

A few of the 166 common suckers were examined, These fish spawn in the last half of June at an age of five years (six springs) and an average length and weight of 13.5 inches and 19 ounces, respectively. No older or larger suckers were seen. All suckers under one pound were immature.

Midge larvae form the main food of common suckers. The building of the dam will not interfere with their spawning or their food, so that increasing numbers of suckers may be expected.

Summary of the Probable Effects of the Dam

(1) Morphometry. The maximum annual fluctuation in water level of 43 feet will cause the average depth of the lake to fluctuate from 44.7 to 47 feet. The area will vary from 700 to 1600 acres. This is unlikely to produce any significant changes in physical or chemical characteristics.

(2) Plankton. No great changes in plankton production are anticipated.

(3) Bottom Fauna. Judging from observations on the Upper Lake, on Lake Minnewanka, Ghost Lake and other reservoirs with fluctuating levels, the bottom fauna will be profoundly changed. The present fauna of midge larvae, shrimps and small clams will be replaced by one largely of midge larvae. The existing shore fauna of stonefly and mayfly nymphs will likely be much reduced.

(4) The trout. The hybrid trout will be seriously affected through reduction of bottom food and loss of spawning facilities. The food selection of the trout shows strong preference for shrimps. These are likely to become scarce, as they have in the Upper lake. The much poorer condition and slower growth of the Upper Lake trout exhibit the effect that may be anticipated. These Upper Lake trout are smaller, lighter at the same lengths, reach a smaller maximum size and spawn at a younger age.

At present the trout spawn in the outlet. It is believed Boulton Creek is, and will continue to be, unreliable for spawning. It is pointed out that the outlet probably provides insufficient stocking at the present time. When it is lost very little reproduction may be expected.

(5) Dolly Varden. The effects on Dolly Varden are likely to be the same as on the trout but to a somewhat lesser degree. Stable flow in Boulton Creek in the fall should provide spawning facilities for some of the Dolly Varden. The fish diet of the larger Dolly Varden relieves their dependance on bottom fauna to some extent.

(6) Common suckers which will thrive on midge larvae and which will spawn in still water will probably find conditions suitable in the flooded lake. It is likely that suckers will increase as the trout and char diminish.

(7) General. That the dam will cause profound changes in the fish population cannot be doubted. We have already the evidence provided by the change from northern to common suckers probably caused by damming the Upper Lake. In other localities one can point to the tremendous change in lake trout in Lake Minnewanka. The loss of food supply in this lake has led to the production of small, plankton feeding lake trout, of little interest to the sport fisherman. In the Spray Lake the cutthroat population, as measured by creel census reports, has seriously deteriorated.

Recommendations

The permit to develop the Pocaterra power site provides a clause requiring compensation for damage to natural resources. The Power Company is required to make every effort to prevent destruction of natural scenic beauties; and, also, to try and provide for continued sport fishing. These requirements are largely ineffectual. It is quite impossible to operate a power dam in a manner consistent with either natural beauty or fish production.

It is not our task to deal with loss of scenic beauty. It is enough to point out that there is no known way of beautifying 900 acres of bare mud and dead stumps.

With regard to sport fishing, damage occurs through curtailment of spawning facilities and reduction of food supplies. There will likely be other changes due to shifts in population balances (e.g., increase of suckers) which cannot be predicted. There is no way of compensating for the loss of food supply. Food supplies can be maintained only by keeping a relatively constant water level. The deterioration of the Lower lake trout to a condition similar to those of the Upper lake cannot be avoided. Only one recommendation can be made:

Recommendation. A hatchery should be established in the Kananaskis lake area. The entire Boulton Creek spawning run should be trapped, stripped and the eggs held to fry stage. The fry should then be widely distributed around the lake margin. The run of Upper lake trout into the canal at Saddle # 4 should also be trapped and handled in the same way, except, of course, the fry would be put in the Upper lake. This would require a summer hatchery building and a crew of at least two men during May, June and July. The Calgary Power Company could be asked to contribute an annual sum to the cost of this operation.

It is perhaps unnecessary to point out again that the hatchery may cure only the loss of spawning facilities. There is no cure for the loss of food.

Description of Photographs

1. Upper Kananaskis lake showing ugly shoreline in spring.

2. The aftermath of construction - garbage on shore of Lower Kananaskis lake, 20 years after it was put there.

3. All that's left of the river between the lakes. Here a trout spawned.

4. The spawning area in the Kananaskis River below the Lower lake.

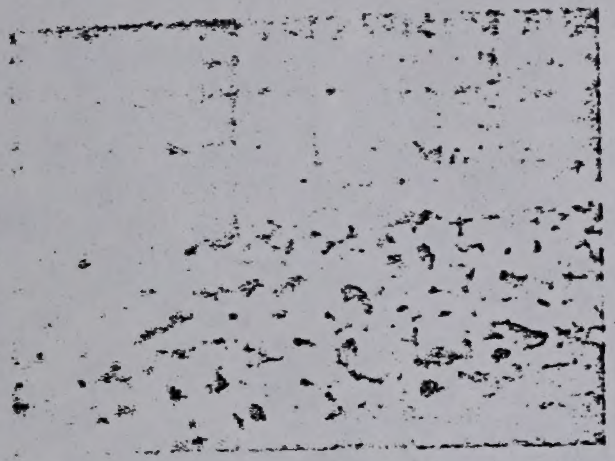
5. A catch of Lower lake fish.

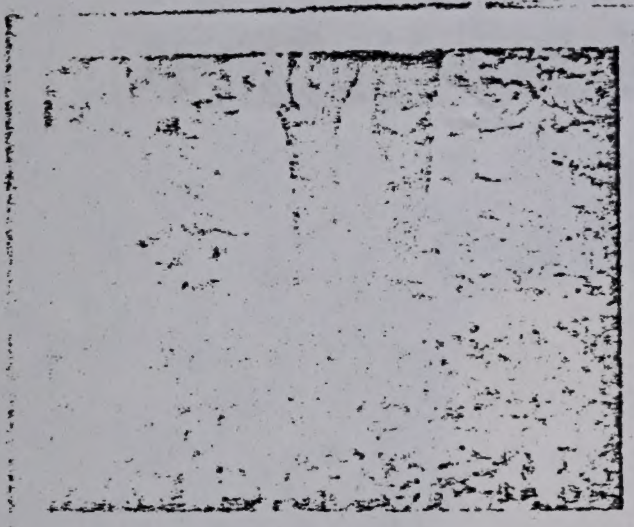
6. Close-up of spawning redd. The dark form is a trout.

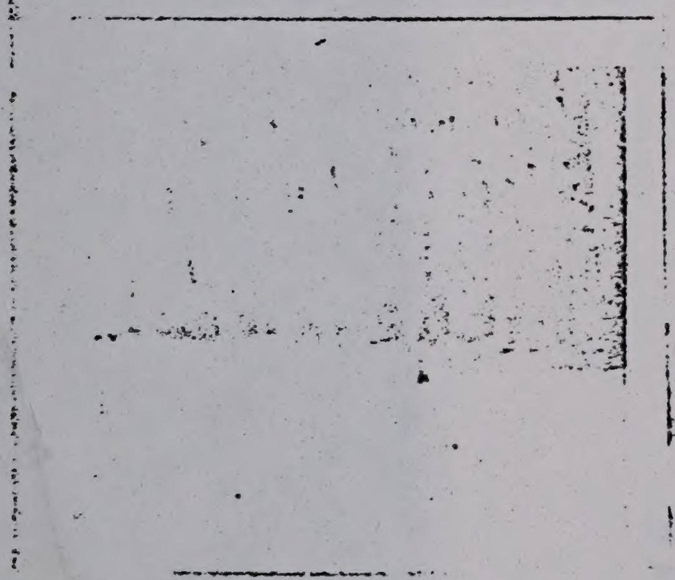
7. Digging in the redds for eggs. A screen is being held to catch any eggs dug up.

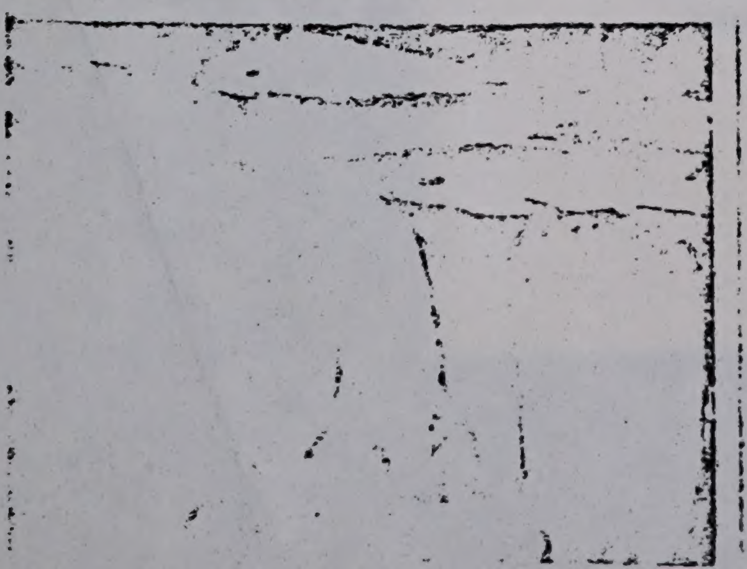
8. Close-up of the screen showing gravel and eggs (small white spheres).

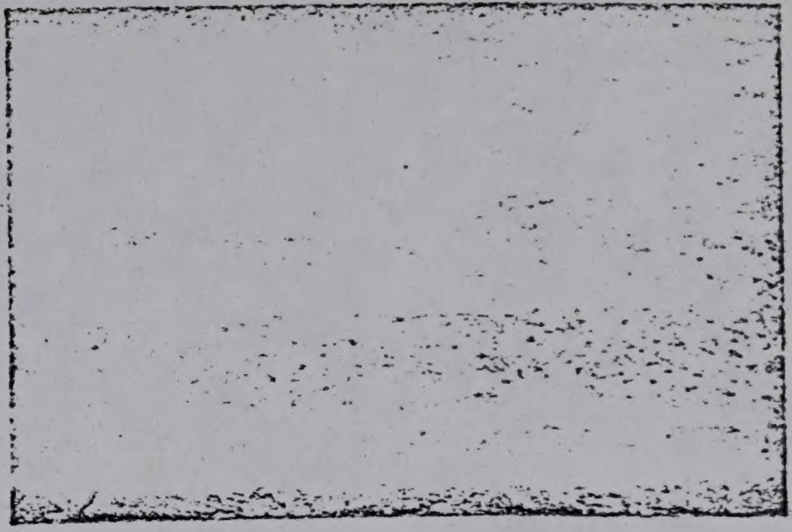
9. A catch of Upper Kananaskis trout.

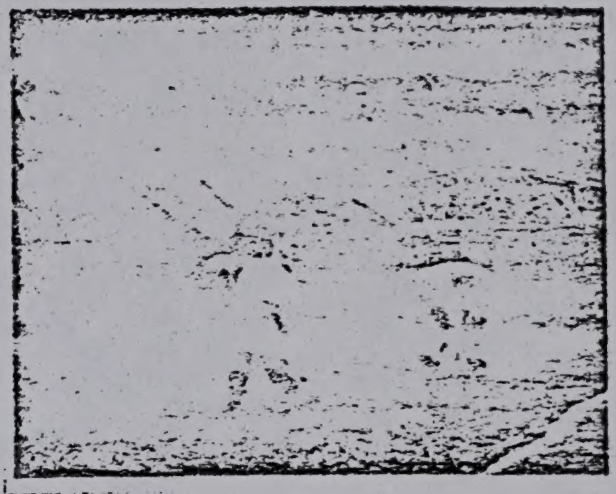


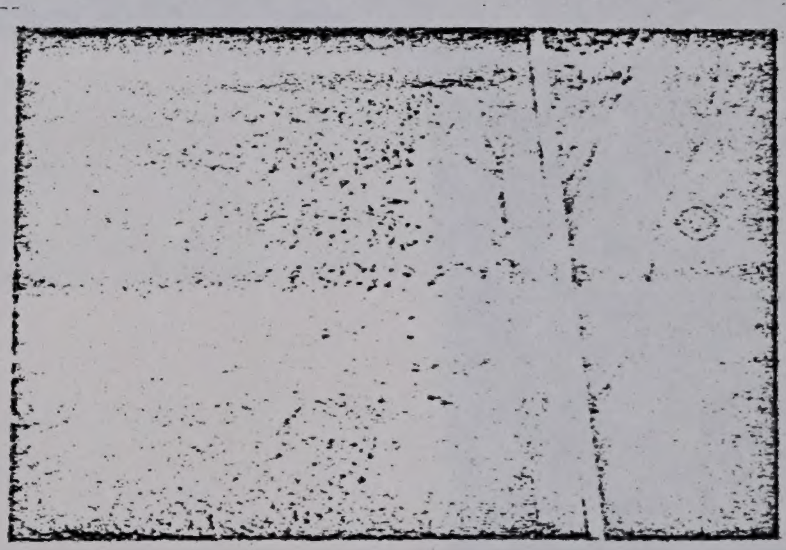


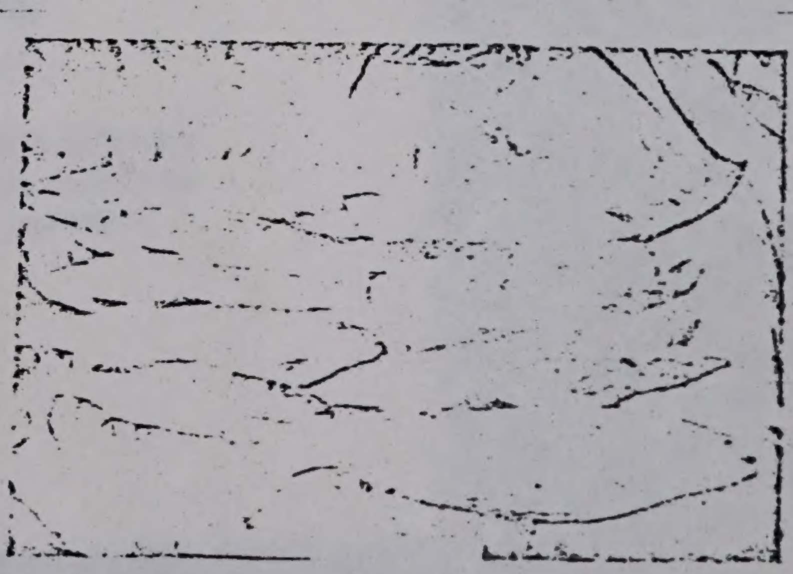












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